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Durable press treated fabrics are the textile manufacturer's current answer to the consumer's demand for garments which retain their original appearance and require minimum care. Despite the advantages attributed to this finishing process, certain undesirable characteristics have appeared to result from the application of this finish. One such problem has been the removal of spots and stains from durable press treated fabrics.

This study was designed to (1) evaluate the penetration of the ten selected oily and oil-borne stains into the five selected durable press treated fabrics, and (2) to determine the success of removal of these stains from the fabrics by a home laundering procedure, a commercial laundering procedure, and a dry cleaning procedure.

The evaluations of both stain penetration and stain removal were made subjectively.

The results of the study showed that:

1. There was a noticeable difference in stain penetration related to the ten stains, whereas there was little difference between the fabrics in stain repellancy.
2. None of the ten stains was completely removed from all the fabrics using any one of the cleaning methods.
3. None of the five fabrics completely released all of the stains using any one of the cleaning methods.
4. None of the three cleaning methods completely removed all the stains from any one of the five fabrics.

5. A pattern was evidenced in the effectiveness of the cleaning methods among the pre-cured fabrics and among the deferred cured fabrics.

6. The dry cleaning procedure was most effective in removing the stains from the durable press fabrics; the home laundering procedure was the least effective.

7. There were positive relationships between certain stain penetration and stain removal ratings.

# THE EFFECTIVENESS OF STAIN REMOVAL FROM DURABLE PRESS TREATED FABRICS USING THREE CLEANING METHODS

by

Mary Elizabeth Wilber

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Pauline E. Keeney
Director

APPROVAL SHEET

This thesis has been approved by the following committee of the Faculty of the Graduate School at the University of North Carolina at Greensboro, Greensboro, North Carolina.

Pauline E. Keeney
Thesis Director

Oral Examination
Committee Members

Eunice M Deemer

Mildred Johnson

Marguerite N. Fellows

Frances B. Buelow

May 1, 1967
Date of Examination

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# CHAPTER I

## INTRODUCTION

### I. STATEMENT OF THE PROBLEM

Through the years manufacturers of textile fabrics have endeavored to construct and finish fabrics to give them optimum appearance and service in consumer use. The interest of consumers in fabrics which would retain their original appearance and require less care has increased in recent years. Emphasis has been placed upon wash-and-wear and durable press finishes to achieve these characteristics. Each of these finishes has been acclaimed as the wonder of the age by eager textile and garment producers and welcomed by the consumer desiring garments which will maintain a neat, well-finished appearance without time-consuming laundering procedures. Unfortunately, the consumer expecting a miracle product frequently has been disillusioned. Properties of the finished fabrics often have prevented the products from performing at the highest levels established for them.

The availability of durable press finished fabrics on the consumer market has, without question, been a boon to the homemaker. However, with all the assets attributed to the durable press treatment, many problems exist which apparently are directly connected with these very assets. One problem of concern to the consumer has been the removal of soil, spots, and stains from the

fabric.

It has been indicated that the affinity of oily and oil-borne stains is increased by the application of the durable press finish. Although research is being carried out to find a process for soil release, at this time soil retention on durable press treated fabrics constitutes a problem of major importance. Until such a process can be applied to produce successful soil release, the homemaker must rely on methods of cleaning available to her.

## II. PURPOSE OF THE STUDY

The purpose of this study was to determine whether stains on durable press finished fabrics can be more readily removed by home laundering, commercial laundering, or dry cleaning. Although these fabrics are made for easy cleaning at home, many homemakers continue to send durable press treated garments to commercial laundries and dry cleaning establishments. It has been recognized that built-up soil often resists removal by home laundering; however, little research has been done related to the effectiveness of soil removal from durable press treated fabrics which may be achieved by commercial laundering and dry cleaning.

The objectives of this study were:

1. To study staining speed and penetration characteristics of selected oily and oil-borne stains applied to selected durable press finished fabrics.

2. To compare the effectiveness of soil removal from the durable press finished fabrics by three methods which could be used by the homemaker.

a. Home laundering.

b. Commercial laundering.

c. Dry cleaning.

## III. LIMITATIONS OF THE STUDY

The durable press treated garments used were selected from those available in the Greensboro, North Carolina area. The fabrics from which the selected garments were made differed in fiber content, construction, and type of durable press finish applied.

The ten stains applied were a selection of oily and oil-borne stains which would be typical of those which might be encountered in use. The cleaning treatments selected were procedures which could be used by the consumer. They were not representative of the numerous variations in laundering and dry cleaning practices.

# CHAPTER II

# REVIEW OF LITERATURE

## I. HIGHLIGHTS OF DURABLE PRESS FINISHING

### Development of Durable Press Treatments

Durable press finishes are the most recent in a series of processes developed to produce lastingly finished fabrics which require minimum care. In recent months the use of these fabrics has become so widespread that they are commonly referred to as "durable press".

Tootal, Broadhurst, Lee Company of England was among the first to become active in research for finishes which would minimize wrinkling. The project, undertaken in the 1920's, was primarily concerned in producing such a finish for cotton and rayon. By that time research had indicated that both acidified formaldehyde and phenol formaldehyde were effective in decreasing the amount of wrinkling in cotton. Subsequent developments led to the use of urea formaldehyde, melamine formaldehyde, dimethylol cyclic ethyleneurea, and similar chemicals on cellulosic fibers.

The wash-and-wear process, which was the ultimate in wrinkle resistance until the advent of durable press, is based on crosslinkages and polymerization. The crosslinkages are "covalent chemical bonds [which] have

been established between molecules of individual fibers."[1] Polymerization refers to a similar reaction between molecules of the resin. These linkages are stabilized by a curing process which consists of heat and pressure. In the wash-and-wear process the resin is applied and the fabric is cured in the flat state before the garment is constructed.

Cone noted that durable press is merely an extension of wash-and-wear.[2] It also is based on the principles of crosslinkages and polymerization. In discussing the accomplishments and problems of durable press, Schultz stated that it does differ from wash-and-wear in that it requires a higher concentration of chemicals, a different curing method and sequence, and new techniques of garment construction.[3] Referring to the deferred cure process, Alexander stated that the entire difference lies in the sequence of operations.[4]

Fiber Content of Durable Press Fabrics

In addition to chemical finishes, the development of thermoplastic fibers was of importance to the success of easy-care fabrics. Fiber content has greatly influenced the performance of durable press fabrics. The first

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[1]Sydney M. Cone, Jr., "A Long Look at Durable Press as the Newest Extension of Wash-and-Wear," Modern Textiles Magazine, XXXXVI (August, 1965), 41.

[2]Ibid., p. 39.

[3]Robert L. Schultz, "Permanent Press: Major Accomplishments and Current Problems," American Dyestuff Reporter, LV (March 14, 1966), 48.

[4]Edward N. Alexander, "Deferred Cure Process for Durable Press," American Dyestuff Reporter, LV (August 1, 1966), 28.

experimentations with the durable press finish were made on 100 per cent cotton. Lee, discussing the place of synthetic fibers in durable press fabrics, noted that although the cellulose component is necessary to form chemical crosslinkages, the high concentration of chemicals considerably tenders the fabric.[5] In search of a component which would add strength, but not detract from the assets of the finish, producers turned to fiber blends.

Schultz, discussing the use of fiber blends, stated that the polyester/cotton blend treated with durable press is superior to other blends for all end uses and is predominate on the consumer market. He acknowledged other blends, but maintained that their use is limited.[6] Fortess and Schultz, citing reasons for their popularity, stated that the polyester blends are economical, and that they provide satisfactory strength, lasting shape, and abrasion resistance.[7] Lee confirmed these statements by noting that while nylon is used primarily for its strength and abrasion resistance, and the acrylics are used for their beauty and styling, 65 per cent or more polyester blended with cotton or rayon is expected to be most satisfactory to the consumer.[8]

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[5]Claude M. Lee, "The Role of Synthetic Fibers in Durable Press Fabrics and Garments," Modern Textiles Magazine, XXXXVI (August, 1965), 46.

[6]Schultz, loc. cit.

[7]Fred Fortess and Robert L. Schultz, "Durable Press Garments in Male Apparel: The Contribution of Polyester Fibers," Modern Textiles Magazine, XXXXVI (August, 1965), 69.

[8]Lee, op. cit., p. 47.

Current Processing Procedures

The majority of durable press fabrics on the consumer market today is produced by either the deferred cure or the pre-cure process. Other methods of achieving durable press finishes are under experimentation; however, they are not used widely in the industry at this time.

Deferred cure. Koret of California, a sportswear manufacturer, led in the experimenting of curing fabrics which had been impregnated with certain resins after the garments had been constructed. By this sequence a memory was formed for pleats and creases which lasted through numerous wearings and launderings. The combination of a wrinkle-free appearance and good crease retention formed by this process surpassed the expectations for wash-and-wear. Alexander explained that the deferred cure process was a cumulation of previous techniques, rather than a completely new discovery.

> They [Koret of California] related it [deferred curing] was based on resins or reactants for cellulose, well known and in use; on pre-sensitized techniques and catalysts used for decades; on delayed action curing or polymerization revealed 28 years ago in the Everglaze process.[9]

In 1961 a patent was granted to Koret for the deferred or post-cure process. Subsequently, the Koratron Company was established as the marketer. The success of the "Koratron" finish was an incentive for individual fabric manufacturers to develop similar finishes of their own. "Super-Crease" by J. P. Stevens and "Dan-Press" by Dan River Mills were two such finishes

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[9]Alexander, loc. cit.

which utilize the deferred cure sequence.[10] Although the techniques vary slightly between companies, the chemical principle involves the

> . . . cellulose (cotton or rayon) in the fabric which is affected by the resin treatment. Man-made fibers are not affected by the resin treatment but, being thermoplastic, they respond to the heat applied during pressing and baking.[11]

Pre-cure. The pre-cure process is a refinement of the wash-and-wear sequence. The fabric which has been impregnated with a resin is partly cured in the flat state. After the garments have been constructed they are permanently shaped with a hot-head press by steam and high temperatures. The chemical action which occurs is basically the same as in the deferred cure process. Cone differentiated between the fabrics used in this process: (1) fabrics containing enough heat sensitive fiber to be head-set, (2) cellulose fibers subjected to a catalyst, and (3) fabrics with a secondary catalyst which use a vinyl sulfone finish.[12] "Coneprest" by Cone Mills, "Burmi-Crease" by Burlington Industries, "Never-Press" by Wamsutta, and "Sharp-Shape" by Everprest are some of the names indicative of the pre-cure durable press process.[13]

Other methods under experimentation. In discussing whether deferred

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[10] What Is Permanent Press? (Newton, Iowa: The Maytag Company, n.d.), p. 2.

[11] "Permanent Press: A Progress Report," American Fabrics, LXVII (Spring 1965), 58.

[12] Cone, op. cit., p. 42.

[13] What Is Permanent Press?, loc. cit.

curing or pre-curing is preferable, Doniger stated that ". . . both routes should be used, depending on the fabric."[14] He suggested combining the two processes by using both hot-head pressing and deferred curing.[15]

Lee mentioned another method of achieving durable press. This process relies completely on the heat sensitivity of the fibers involved.

> Fabrics made of 100 percent polyester, 50 percent or more polyester intimately blended with acrylic, 100 percent polyester in the filling with blends of polyester in the warp have been "durably cured" at temperatures in the range of 300° and 400° F.[16]

Micro-stretching, a recently developed mechanical process, was claimed to have overcome several limitations of durable press. It improves strength, can be applied to lighter weight fabrics, and withstands more concentrated chemical treatments.[17]

## II. SOILING AND STAINING

### Characteristics of Soil

Soil, in either the solid or fluid state, comes from many sources. Getchell, reporting on the resistance of cotton to soil, stated that soil in the fluid state is usually in the form of grease or oil; in the solid state the particles

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[14]"How Apparel Makers Cope With DP Problems," American Dyestuff Reporter, LV (February 28, 1966), 24.

[15]Ibid.

[16]Lee, loc. cit.

[17]"New Process Said to Expand Range of DP Cottons," Modern Textiles Magazine, XXXXVI (August, 1965), 54.

are more inert.[18] He differentiated between the terms generally used.

> When uniformly distributed over the surface, it is called dirt or soil; when confined to a small area it is termed a spot, which if extremely difficult to remove, becomes a stain.[19]

Role of oil in soiling and staining. Hill, in discussing artificial soiling listed four types of dirt found on clothing: albuminous material such as eggs and body secretions, finely divided matter such as dust, saponifiable oils, and nonsaponifiable oils.[20] All but one category involves soil which has a natural oil content. Oily soil comes from such common sources as secretions from the body, food fats, cooking oils, automobile grease, liquid fuels, and machine oils. Regardless of whether or not the soil itself is of an oily nature, the binding property of the oil is important since it accounts for a large portion of soiling. A report of the New York Section of the American Association of Textile Chemists and Colorists on measurement of soiling referred to the conclusions of a study by Snell and others which noted that dirt is held to the fabric by

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[18]Nelson F. Getchell, Cotton Quality Study III: Resistance to Soiling (Memphis, Tenn.: National Cotton Council of America, 1955), p. 10.

[19]Ibid.

[20]A. Elizabeth Hill, "Artificial Soiling of Cotton Fabrics Preparatory to Laundering Studies," Journal of Agricultural Research, XXXXIX (October 1, 1929), 539.

mechanical and electrostatic forces in addition to oil bonding.[21] It was also reported that Masland, one of the earlier authorities on soiling, particularly emphasized fiber morphology as the cause of soil retention.[22]

Utermohlen and others studying the influence of oily soil, stated that the oily portion of soil is naturally adherent to the fabric.[23] The degree of its affinity varies depending on the fiber, the yarn, the weave, and the finish. Numerous studies have indicated that polyesters retain a higher percentage of oil than many other fibers. Schwarz and others, studying the measurement of fabric soil, stated that open weaves allow soil to penetrate readily, while close, even surfaces retard soil penetration.[24] McLaughlin's study of oil retention on polyesters eliminated yarn structure and weaves as variables by using "Kodar" and "Mylar" films.[25]

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[21]F. D. Snell, C. Snell, and Reich, "Nature of Dirt and Methods of Retention at the Surface," Journal of American Oil Chemists Society, XXVII (1950), 62, cited by Eugene W. K. Schwarz, et al., "Measurement of Fabric Soiling," A Report to the Thirtieth Annual Convention of the American Association of Textile Chemists and Colorists, New York, October 19, 1951, presented in American Dyestuff Reporter, XLI (May 26, 1952), 539.

[22]C. H. Masland, "Soil Retention of Various Fibers," Rayon Textile Monthly (October-November, 1939), n. p., cited by Schwarz, et al., loc. cit.

[23]William P. Utermohlen, et al., "Detergency Studies IV: Influence of Oily Soil Upon the Removal of Pigment Soil," Textile Research Journal, XIX (August, 1949), 489.

[24]Schwarz, et al., loc. cit.

[25]Marylyn M. McLaughlin, "The Relationship Between Temperature of Laundering and Oil Retention on Polyesters" (unpublished Master's thesis, Cornell University, Ithaca, New York, 1965), p. 3.

Staining of durable press. Some finishes, such as starch, retard soil penetration by forming a tight film on the surface. Conflicting views have arisen concerning the affinity of soil and stains to fabrics with a durable press finish. Discussing the soiling of durable press fabrics, Fortess noted that:

> . . . frequently surface finishes of a polymeric nature are applied to the durable press fabric . . . these finishes, whether they are on the polyester or on the cotton attract and hold oily soil.[26]

He continued to state that the concentrated chemical finish used inhibits the swelling action of the cotton fibers, and therefore, retards soil release during laundering.[27] However, information especially prepared for the homemaker stated that the durable press process does not affect soil removal.[28]

## Stain Removal

Factors influencing stain affinity. Soil removal depends on many variables. These include: the inherent properties of the fabric and the stain, the time elapsing between staining and cleaning, and the method of removal used.

Getchell, discussing resistance to soiling, noted that the ease of oil removal is influenced by the ability of the oil to form a film and by the degree

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[26]Statement by Fred Fortess, following presentation of papers of the American Association for Textile Technology, Inc., New York, September 7, 1966, presented in Modern Textiles Magazine, XXXXVII (November, 1966), 54.

[27]Ibid.

[28]The Importance of Durable or Permanent Press (Newton, Iowa: The Maytag Company, n.d.)

of saturation. As the chemical change progresses in the soil, the stain becomes more difficult to remove.[29] Mellan also emphasized the importance of promptness for the effective removal of stains.[30] In contrast, one study referred to the findings of Hartley and Elsworth noting that oils were removed from polyesters more readily after a storage period and exposure to light, which allowed oxidation to occur.[31]

Detergency. Detergency, the act of cleansing, involves the removal of soil. Leffingwell, discussing detergency, defined an effective detergent as one which removes solid soil, prevents soil from redepositing on the fabric, and emulsifies oil and grease.[32] She stated that the cleaning agent must penetrate both the inter-yarn and the inter-fiber systems where the soil is most deeply imbedded.[33] In a report on detergents Borghetty stated that:

> Soaps typify all such products of the detergent type; they possess a long hydrocarbon chain . . . with one terminal . . . water soluble group. For instance, the non-polar chain attaches

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[29]Getchell, op. cit., p. 11.

[30]Ibert Mellan and Eleanor Mellan, Removing Spots and Stains (New York: Chemical Publishing Company, Inc., 1959), p. 7.

[31]R. S. Hartley and F. F. Elsworth, "Scouring of Wool-Terylene Cloths," Journal of the Society of Dyers and Colourists, LXXIII (1957), 507, cited by McLaughlin, op. cit., p. 22.

[32]Georgia Leffingwell, "Elements of Detergency," Rayon and Synthetic Textiles, XXX (March, 1949), 83.

[33]Ibid., p. 84.

> itself to oil and the total is floated away or emulsified in the water because of the polar group. The longer the fatty chain, the higher the detergency.[34]

This explanation combined two phases of detergency, the emulsifying action and the colloidal stage.

Reporting on types of detergents, Leffingwell stated that synthetic detergents were often preferred over soaps since soaps are not neutral in water solution. Their sensitivity to metallic ions found in hard water was also a disadvantage. She noted that synthetic detergents are fairly soluble in hard water and do not exhibit sensitivity to acid solutions and metallic ions.[35] Billica, reporting at the Textile Research Seminar on oil removal from nylon and polyester, concluded that nonionic detergents were more effective than anionic detergents.[36]

Detergency of durable press. Since little technical information was available on the detergency of durable press, sources readily available to the consumer were consulted. Generally, recommendations for laundering durable press followed the methods used for wash-and-wear. The special washer cycle for wash-and-wear usually consists of a warm wash and cold rinses. The Good Housekeeping Institute reported that wrinkling became less severe as the

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[34]H. C. Borghetty, "Detergents in the Textile Industry," Rayon and Synthetic Textiles, XXX (March, 1949), 86.

[35]Leffingwell, loc. cit.

[36]H. R. Billica, Textile Research Institute Seminar, Princeton, New Jersey, October 29, 1964, cited by McLaughlin, op. cit., p. 32.

agitation time was decreased.[37] This report also indicated that cold water (75 degrees Fahrenheit or below) and cold water detergent removed light soil; warm water (90 to 110 degrees Fahrenheit) removed medium soil, and that hot water (140 to 160 degrees Fahrenheit) was required for heavy soil. However, as the temperature was increased, wrinkling became more noticeable.[38] When automatic dryers were used the temperature and time of removal were of major concern. Ideally, durable press garments were dried with warm air until they were barely dry. Wrinkling was prevented by immediately hanging up the garments.[39]

The prompt removal of spots and stains was emphasized in laundering instructions prepared for consumer use. Light applications of cleaning fluid were recommended to dissolve oily stains. All-fabric bleach was also mentioned as being effective in the removal of stains.

Since durable press fabrics were designed for easy home care, little information was available on their reaction to commercial laundering and dry cleaning. It was noted that the concentrated cleaning agents, bleaches, and finishes used in commercial launderies would not affect the finish favorably.[40]

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[37]"What's the Story on Durable Press," Good Housekeeping, CLXII (April, 1966), 199.

[38]Ibid., pp. 199-200.

[39]Ibid., p. 199.

[40]Madam . . . The Ironing Is Done - And Forever (Bismarck, N. D.: Gold Seal Company, 1966), p. 2.

However, it has been found very difficult to evaluate commercial launderability because of the lack of standard techniques practiced.[41] Dry cleaning was suggested in cases of stubborn stains.[42]

## III. SOIL-RELEASING DURABLE PRESS FABRICS

Acknowledging that staining is a problem on fabric with a durable press finish, fabric manufacturers have been involved in research to discover a soil-releasing component. Two completely different methods have been found.

### Electronic Radiation Process

A unique use of electronic radiation has been devised by Deering Milliken, and later by Burlington Industries, for releasing soil from polyester/cotton fabrics. Suchecki, commenting on the innovation, stated that:

> In brief, properly excited electrons impinge on the fibers, or passing fabric, to cure, polymerize or graft a suitable chemical product onto the fiber at room temperature in the presence of free air.[43]

The grafted chemical in this case was one which decreased soil penetration. While the retardation of oily stains was of particular concern, Burlington Industries stated that their "Come Clean" was also effective against such stains as

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[41] "DP Researchers Vexed By Laundry Problems," Daily News Record, January 30, 1967, p. 2.

[42] Madam . . . The Ironing Is Done - And Forever, loc. cit.

[43] Stanley M. Suchecki, "Durable Press: Phase 2 (Continued)," Textile Industries, CXXX (September, 1966), 133.

milk, wine, coffee, and cranberry juice.[44] Comparing Deering Milliken's "Visa" with standard post-cured fabrics, an article in the Daily News Record stated that it had been found that soil removal was superior on "Visa",

> . . . but two or more washings were required to remove all the soil. Moreover, the DM [Deering Milliken] recommendation for washing at 140 degrees with strong detergents seemed to preclude optimum washing in home laundries.[45]

Burlington Industries claimed that stains could be removed from "Come Clean" after being on the fabric a week. They also stated that the effectiveness of the finish is not changed by dry cleaning or hot-head pressing.[46]

Chemical Finishing Process

The other method of creating the soil release property on durable press involves a chemical finish. In England it is marketed as "Permalose"; in this country, as "Cirrasol PT". This process, discussed in Modern Textiles Magazine, was designed by Celanese and is suitable for application on polyesters and polyester blends. It is applied in a pad-dry-bake sequence and may be fixed at the time the heat setting of the durable press finish occurs.[47] The

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44"'Come Clean' Soil Release Is Introduced For Durable Press," Burlington Review, IX (February, 1967), 1.

45"Milliken Won't Ship Visa Until September," Daily News Record, July 29, 1966, p. 13.

46"'Come Clean' Soil Release Is Introduced For Durable Press," loc. cit.

47"New Finish for Polyesters: Improving Antistatic and Anti-Soiling Properties," Modern Textiles Magazine, XXXXVII (November, 1966), 29.

finish was claimed not only to resist soiling, but also to facilitate soil removal. "Cirrasol PT" proved ". . . resistant to all commercial drycleaning treatments . . ." and repeated launderings in solutions under 140 degrees Fahrenheit which were not highly alkaline.[48]

## IV. SUMMARY

Numerous references have been cited which deal with the development of the durable press finish and the processes used to achieve crease retention and freedom from wrinkling. Sources of information on detergency and soil removal were also readily available. However, little information was found which specifically related to the removal of soil and stains from durable press treated fabrics. Generally, it was agreed that the removal of stains from fabrics treated with durable press is difficult. The recognition of this problem has initiated research directed toward the development of anti-soiling or soil-releasing components to be applied to durable press treated fabrics.

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[48] Ibid.

# CHAPTER III

## PROCEDURE

### I. SELECTION OF GARMENTS

The durable press garments selected were chosen from those available to the consumer in the Greensboro, North Carolina area. Those selected can be categorized only as garments made of durable press treated fabric. They differed in type of garment, fiber content, and weave. The methods of applying the durable press finish also varied. Each was applied by a different manufacturer. Two of the garments (V and W) were cured before being manufactured (pre-cured); three (X, Y, and Z) were cured after being manufactured (deferred cured). The selected garments were coded as shown in Table I.

TABLE I

CODING AND DESCRIPTION OF THE SELECTED DURABLE PRESS TREATED GARMENTS

| Code | Garment | Fiber Content | Weave |
|---|---|---|---|
| V | Man's dress shirt | 65/35 polyester/cotton | plain |
| W | Boy's trousers | 50/50 acrylic/polyester | twill |
| X | Woman's skirt | 50/50 polyester/cotton | plain |
| Y | Man's trousers | 85/15 cotton/nylon | twill |
| Z | Man's trousers | 50/50 polyester/cotton | twill |

## II. SELECTION OF STAINS

Although many textile manufacturers are presently developing and testing various methods of soil release from durable press fabrics, the affinity for oily and oil-borne stains still poses a problem of concern to the consumer. Therefore, certain oily and oil-borne stains were selected to be used in this study in order to determine how readily they might be removed by cleaning treatments a homemaker would be likely to use.

The following stains were selected for their high oil content and coded for use in the study:

| Code | Stains |
|---|---|
| 1 | Light weight machine oil |
| 2 | French dressing |
| 3 | Blue cheese dressing |
| 4 | Chocolate syrup |
| 5 | Bacon grease |
| 6 | Cooking oil |
| 7 | Gravy |
| 8 | Mayonnaise |
| 9 | Margarine |
| 10 | Automobile grease |

## III. PREPARATION OF SAMPLES

All stains used in the study were applied to three inch squares from the fabric of each of the five garments. A total of four hundred three inch squares were used with eighty squares taken from each garment. These were used (1) to establish standards to be used by the judges in rating the effectiveness of stain removal and (2) to make up the stained test pieces to be used in the three

cleaning treatments.

Description of standard or control charts. A standard chart was established for each of the ten stains used in the experiment. These standards were designed to represent to the judges the appearance of each of the five fabrics in its original unstained condition and the same fabric in its stained condition (Figure 1).

Description of the stained test block. Three test blocks measuring twelve by fifteen inches were cut from each garment. In cases where there was not sufficient fabric to form a rectangle of this size, smaller sections of the fabric were stitched together to form the test block. This block form was used to facilitate staining and to minimize fraying of the squares.

Each block was marked to indicate the position of twenty three-inch squares. This was so designed to permit two replications of each of the ten stains (Figure 2). The three inch squares of each block were coded for judging as follows:

1. Letters V through Z to indicate the five fabrics
2. Numbers 1 through 10 to indicate the ten stains
3. Letters B, C, and D to indicate home laundering, commerical laundering, and dry cleaning respectively
4. Numbers 1 and 2 to indicate each replication

## IV. APPLICATION OF STAINS

Each test block to which the stains were to be applied was placed on a towel over a drying screen. One drop of each liquid stain was dropped on the

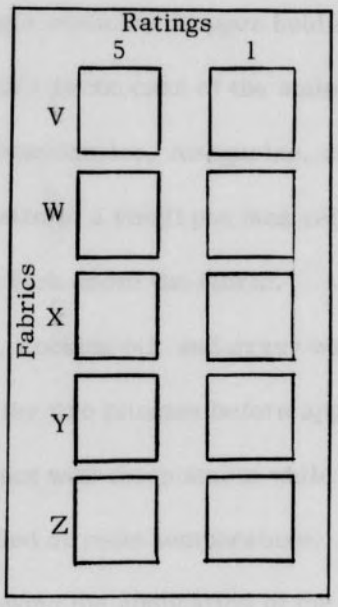


FIGURE 1

A STANDARD CHART ESTABLISHED FOR THE EVALUATION OF THE REMOVAL OF EACH OF THE TEN STAINS

| | | | |
|---|---|---|---|
| 1 | 6 | 1 | 6 |
| 2 | 7 | 2 | 7 |
| 3 | 8 | 3 | 8 |
| 4 | 9 | 4 | 9 |
| 5 | 10 | 5 | 10 |

FIGURE 2

THE PLACEMENT OF THE TEN STAINS ON THE TEST BLOCK

center of each square using a medicine dropper held one inch above the fabric to insure equal force of impact. In the case of the stains which were too viscous to be applied in this manner (mayonnaise, margarine, and automobile grease), a globule approximately the size of a small pea was released from the tip of a spatula at the height of one inch above the fabric.

The bacon grease, cooking oil, and gravy were heated in a water bath at 180 degrees Fahrenheit for five minutes before application since the consumer most often comes into contact with these stains while they are either warm or hot. The other stains were applied at room temperature.

Five minutes following the application of the stain to the fabric a subjective analysis was made of the stain penetration. Any excess staining substance which the fabric had not absorbed at this time was removed carefully with a spatula. The stain was allowed to remain on the fabric for two or more days, during which time the stain set. It has been realized that the prompt removal of stains often determines the ease and success of removal. However, many homemakers do not remove stains promptly and allow stained and soiled garments to accumulate. Since the study was designed to approximate procedures which might be practiced by homemakers, the stains were allowed to set.

The test blocks were sewed together into three large blocks so that a cleaning treatment could be applied to all stains at one time.

## V. TREATMENT PROCEDURES

Home laundering. For the home laundering treatment one large block

which had been sewed together was placed in a net laundry bag and laundered in a Philco CE734 Duomatic at the "Wash-'N-Wear" setting. The wash and rinse cycles, which lasted approximately thirty-five minutes, consisted of a warm water wash (90 ± 5 degrees Fahrenheit), a cold spray rinse, and cold deep rinses (75 ± 5 degrees Fahrenheit). One quarter cup of a low sudsing granular detergent was added at the beginning of the wash cycle. The fabrics were dried at the "Wash-'N-Wear" setting which was about twenty-five minutes in duration.

Commercial laundering. One large block was sent to a local commercial laundry to be treated as other durable press finished garments would be treated. It was requested that no special treatment be given to the stains before or after laundering. The fabric was laundered in a cylinder type machine at 105 ± 5 degrees Fahrenheit for sixteen minutes. It was then subjected to four rinses of two minutes each at 90 degrees Fahrenheit. A brief extraction period was followed by a thirty-five minutes tumble dry period.

Dry cleaning. The third block was sent to a local dry cleaning establishment to be treated as other durable press treated garments. Again, it was requested that no special treatment be given to the stains before or after dry cleaning. The fabric was subjected to Stoddard solvent charged with one-half per cent Sanitone during a thirty minute wash period. A three minute extraction period and a twenty-five minute drying period followed.

## VI. EVALUATION OF STAIN PENETRATION

Since no standard evaluation for stain penetration was found, procedure

for subjective analysis in "The Staining Characteristics of Cotton Wash-Wear Fabrics" by Willingham was used. Visual judgments were made by the researcher.

Five minutes following the application of the stains the characteristics of the staining substances were scored as follows:

5 Forms a ball on fabric
4 Forms a ball on fabric, then is absorbed
3 Is not absorbed readily; nor built-up on fabric
2 Is absorbed in a small area
1 Is absorbed in a wide area[1]

## VII. EVALUATION OF STAIN REMOVAL

The original unstained fabric squares and the stained squares shown on the control charts were established as divergent ends of a rating scale, which was an adaptation of the scale used by the American Association of Textile Chemists and Colorists in many of their procedures.[2]

5 No evidence of stain
4 Some evidence of stain
3 Moderate evidence of stain
2 Some evidence of removal
1 No evidence of removal[3]

The test blocks which had been subjected to the three cleaning treatments

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[1]Alice J. Willingham, "The Staining Characteristics of Cotton Wash-Wear Fabrics," (unpublished Grant-in-Aid, No. 91, The Research Council, The Woman's College of the University of North Carolina, Greensboro, 1961), p. 14.

[2]1966 Technical Manual of the American Association of Textile Chemists and Colorists (New York: Howes Publishing Company, 1966), p. B-56.

[3]Willingham, op. cit., p. 16.

were cut apart and each three inch square was mounted on a four by six inch white card. These cards were then sorted according to stains and placed in ten categories, each of which was composed of thirty cards. Within each category the cards were arranged randomly. The mounted squares were compared one at a time with the control chart which was placed at a forty-five degree angle under fluorescent lighting.

Three persons, unfamiliar with the study, viewed the fabrics which had been subjected to the three cleaning methods and separately judged them according to the rating scale. A score sheet was devised which included the thirty ratings for one stain on the various fabrics cleaned by the selected methods (Appendix A).

# CHAPTER IV

## PRESENTATION OF DATA

This chapter presents the data obtained in examining the staining and stain releasing characteristics of durable press fabrics using three cleaning methods. The objectives of this study were to determine (1) the staining speed and penetration characteristics of oily and oil-borne stains applied to durable press finished fabrics, and (2) the effectiveness of stain removal from these fabrics by selected procedures of home laundering, commercial laundering, and dry cleaning.

Five garments made from durable press treated fabrics were selected from those available in the Greensboro, North Carolina area. Since a variety of durable press fabrics was desired to indicate possible variations in performance, garments were selected which differed in fiber content, fabric construction, and type of durable press finish applied. The garments consisted of two pairs of men's trousers, one pair of boy's trousers, a man's dress shirt, and a woman's skirt.

Ten oily and oil-borne stains were applied to the five fabrics to be judged according to stain penetration and stain removal. The stains were: light weight machine oil, French dressing, blue cheese dressing, chocolate syrup, bacon grease, cooking oil, gravy, mayonnaise, margarine, and automobile grease.

# I. EVALUATION OF STAIN PENETRATION

One of the objectives of this study was to determine the staining speed and penetration characteristics of the stains five minutes after their application to the fabrics. The results were judged on a five point scale. A rating of 5 indicated that the stain remained on the surface of the fabric. A rating of 1 indicated that the stain was readily absorbed into a wide area of the fabric. Ratings of 4, 3, and 2 indicated stages of penetration between the two extremes. The mean rating of each fabric and stain is shown in Table II.

## Stain Penetration

The mean ratings for the stains ranged from 5.00 to 1.80. French dressing, blue cheese dressing, chocolate syrup, gravy, margarine, and automobile grease received mean ratings above 4.00. Therefore, these stains can be considered to have had little penetration into the fabrics. The mean ratings for light weight machine oil, bacon grease, and cooking oil indicated that they were absorbed readily into the fabrics.

## Fabric Staining Characteristics

The mean ratings of stain penetration into the five durable press fabrics ranged from a rating of 4.08 to 3.31. The fabric which repelled the stains to the greatest degree (X) and the fabric which was rated as the most absorbent (Z) were both 50/50 polyester/cotton which had been treated by the deferred cure process. The fabric with the greatest repellancy was a plain

TABLE II

MEAN RATINGS FOR STAIN PENETRATION INTO FIVE DURABLE PRESS TREATED FABRICS

| Fabric | Stains 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Mean for fabrics |
|---|---|---|---|---|---|---|---|---|---|---|---|
| V | 1.00 | 5.00 | 5.00 | 5.00 | 1.00 | 2.50 | 4.00 | 5.00 | 5.00 | 5.00 | 3.85 |
| W | 2.00 | 5.00 | 5.00 | 5.00 | 2.00 | 2.00 | 4.00 | 5.00 | 5.00 | 5.00 | 4.00 |
| X | 1.77 | 5.00 | 5.00 | 5.00 | 2.00 | 2.00 | 5.00 | 5.00 | 5.00 | 5.00 | 4.08 |
| Y | 2.00 | 4.67 | 5.00 | 5.00 | 2.00 | 2.00 | 4.00 | 4.67 | 5.00 | 5.00 | 3.93 |
| Z | 2.00 | 4.00 | 5.00 | 5.00 | 2.00 | 2.00 | 5.00 | 4.17 | 4.00 | 5.00 | 3.31 |
| Mean for stains | 1.75 | 4.73 | 5.00 | 5.00 | 1.80 | 2.10 | 4.40 | 4.77 | 4.80 | 5.00 | |

Fabrics

| | |
|---|---|
| V | 65/35 polyester/cotton, plain weave, pre-cured |
| W | 50/50 acrylic/polyester, twill weave, pre-cured |
| X | 50/50 polyester/cotton, plain weave, deferred cured |
| Y | 85/15 cotton/nylon, twill weave, deferred cured |
| Z | 50/50 polyester/cotton, twill weave, deferred cured |

Stains

| | | | |
|---|---|---|---|
| 1 | Light weight machine oil | 6 | Cooking oil |
| 2 | French dressing | 7 | Gravy |
| 3 | Blue cheese dressing | 8 | Mayonnaise |
| 4 | Chocolate syrup | 9 | Margarine |
| 5 | Bacon grease | 10 | Automobile grease |

Stain penetration rating scale

| | |
|---|---|
| 5 | Forms a ball on the fabric |
| 4 | Forms a ball on the fabric, then is absorbed |
| 3 | Is not absorbed readily; nor built up on the fabric |
| 2 | Is absorbed readily in a small area |
| 1 | Is absorbed readily in a wide area |

weave, whereas the fabric with the lowest repellancy was a twill weave.

## II. EVALUATION OF STAIN REMOVAL

The second major objective of this study was to determine variations in the effectiveness of the removal of the selected stains from the five durable press fabrics using selected procedures of home laundering, commercial laundering, and dry cleaning. The stained fabrics which had been subjected to a cleaning treatment were judged by three persons using a scale proceeding from 5, no evidence of stain; to a rating of 1, where there was no evidence of removal. The mean ratings for stain removal from the five fabrics using the three cleaning methods is shown in Table III.

An analysis of variance was used to determine whether a significant difference existed between the ratings of the three judges which separately totaled 996, 1073, and 1146. The F-score exceeded the five per cent level of significance, indicating that there was a significant difference between the total ratings. Although the difference between the total of the 300 ratings given by each judge was significant, the mean ratings of the judges varied only slightly, ranging from 3.82 to 3.32.

### Removal of Stains

A comparison of the effectiveness of stain removal from the durable press fabrics by three cleaning methods is shown in Figure 3. The variables of fabric and cleaning method are illustrated for each stain. All mean ratings are

## CODE FOR TABLE III

### Fabrics

| | |
|---|---|
| V | 65/35 polyester cotton, plain weave, pre-cured |
| W | 50/50 acrylic/polyester, twill weave, pre-cured |
| X | 50/50 polyester/cotton, plain weave, deferred cured |
| Y | 85/15 cotton/nylon, twill weave, deferred cured |
| Z | 50/50 polyester/cotton, twill weave, deferred cured |

### Stains

| | | | |
|---|---|---|---|
| 1 | Light weight machine oil | 6 | Cooking oil |
| 2 | French dressing | 7 | Gravy |
| 3 | Blue cheese dressing | 8 | Mayonnaise |
| 4 | Chocolate syrup | 9 | Margarine |
| 5 | Bacon grease | 10 | Automobile grease |

### Cleaning methods

| | |
|---|---|
| B | Home laundering |
| C | Commercial laundering |
| D | Dry cleaning |

### Stain removal rating scale

| | |
|---|---|
| 5 | No evidence of stain |
| 4 | Some evidence of stain |
| 3 | Moderate evidence of stain |
| 2 | Some evidence of removal |
| 1 | No evidence of removal |

MEAN RATINGS F
PRESS TREATED

| Fabric | Method | 1 | 2 |
|---|---|---|---|
| V | B | 3.50 | 3.50 |
| | C | 3.17 | 3.50 |
| | D | 3.67 | 3.00 |
| | Mean | 3.45 | 3.33 |
| W | B | 3.67 | 3.83 |
| | C | 3.17 | 3.67 |
| | D | 3.67 | 4.83 |
| | Mean | 3.50 | 4.11 |
| X | B | 1.50 | 2.33 |
| | C | 1.50 | 2.83 |
| | D | 3.67 | 2.00 |
| | Mean | 2.22 | 2.39 |
| Y | B | 3.33 | 3.17 |
| | C | 2.83 | 4.17 |
| | D | 3.50 | 2.50 |
| | Mean | 3.22 | 3.28 |
| Z | B | 1.50 | 3.00 |
| | C | 1.00 | 3.00 |
| | D | 4.33 | 2.33 |
| | Mean | 2.28 | 2.78 |
| Mean of fabrics | B | 2.70 | 3.17 |
| | C | 2.33 | 3.43 |
| | D | 3.77 | 2.93 |
| Mean of means | | 2.93 | 3.18 |

TABLE III

MEAN RATINGS FOR STAIN REMOVAL FROM FIVE DURABLE PRESS TREATED FABRICS BY THREE CLEANING METHODS

| Fabric | Method | Stains | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| V | B | 3.50 | 3.50 | 2.67 | 5.00 | 3.50 | 3.67 | 4.67 | 3.33 | 4.33 | 2.17 | 3.63 |
| | C | 3.17 | 3.50 | 4.33 | 5.00 | 4.83 | 3.33 | 4.83 | 4.83 | 3.33 | 2.33 | 3.95 |
| | D | 3.67 | 3.00 | 2.50 | 5.00 | 3.67 | 3.67 | 2.83 | 1.50 | 4.83 | 4.67 | 3.53 |
| | Mean | 3.45 | 3.33 | 3.17 | 5.00 | 3.56 | 3.56 | 4.11 | 3.22 | 4.16 | 3.06 | 3.70 |
| W | B | 3.67 | 3.83 | 4.33 | 4.33 | 3.50 | 3.67 | 4.83 | 4.00 | 4.83 | 5.00 | 4.20 |
| | C | 3.17 | 3.67 | 4.50 | 5.00 | 3.67 | 3.67 | 4.83 | 4.50 | 4.83 | 4.83 | 4.27 |
| | D | 3.67 | 4.83 | 4.00 | 3.17 | 3.50 | 3.50 | 4.33 | 4.67 | 4.83 | 4.83 | 4.13 |
| | Mean | 3.50 | 4.11 | 4.28 | 4.17 | 3.56 | 3.61 | 4.66 | 4.39 | 4.83 | 4.89 | 4.20 |
| X | B | 1.50 | 2.33 | 2.67 | 5.00 | 2.33 | 2.50 | 4.83 | 1.00 | 2.00 | 2.67 | 2.68 |
| | C | 1.50 | 2.83 | 2.50 | 5.00 | 3.17 | 2.67 | 4.67 | 2.00 | 2.33 | 2.83 | 2.95 |
| | D | 3.67 | 2.00 | 2.83 | 3.67 | 4.67 | 5.00 | 4.17 | 2.33 | 5.00 | 4.83 | 3.82 |
| | Mean | 2.22 | 2.39 | 2.67 | 4.56 | 3.39 | 3.39 | 4.56 | 1.78 | 3.11 | 3.44 | 3.15 |
| Y | B | 3.33 | 3.17 | 2.50 | 5.00 | 1.00 | 1.33 | 3.50 | 2.67 | 1.83 | 2.83 | 2.72 |
| | C | 2.83 | 4.17 | 2.83 | 4.83 | 2.67 | 4.50 | 4.50 | 4.33 | 3.33 | 2.50 | 3.65 |
| | D | 3.50 | 2.50 | 2.50 | 5.00 | 5.00 | 5.00 | 3.83 | 4.33 | 5.00 | 4.83 | 4.15 |
| | Mean | 3.22 | 3.28 | 2.61 | 4.94 | 2.89 | 3.61 | 3.94 | 3.78 | 3.39 | 3.39 | 3.51 |
| Z | B | 1.50 | 3.00 | 2.50 | 5.00 | 1.17 | 1.50 | 3.33 | 3.50 | 1.33 | 2.67 | 2.55 |
| | C | 1.00 | 3.00 | 2.33 | 5.00 | 2.50 | 4.33 | 4.83 | 4.83 | 4.00 | 2.50 | 3.43 |
| | D | 4.33 | 2.33 | 2.33 | 5.00 | 5.00 | 5.00 | 3.00 | 2.17 | 4.00 | 5.00 | 3.82 |
| | Mean | 2.28 | 2.78 | 2.39 | 5.00 | 2.89 | 3.61 | 3.72 | 3.50 | 3.11 | 3.39 | 3.27 |
| Mean of fabrics | B | 2.70 | 3.17 | 2.93 | 4.87 | 2.30 | 2.53 | 4.23 | 2.90 | 2.86 | 3.07 | 3.16 |
| | C | 2.33 | 3.43 | 3.30 | 4.97 | 3.37 | 3.70 | 4.73 | 4.10 | 3.56 | 3.00 | 3.65 |
| | D | 3.77 | 2.93 | 2.83 | 4.37 | 4.37 | 4.43 | 3.63 | 3.00 | 4.73 | 4.83 | 3.89 |
| Mean of means | | 2.93 | 3.18 | 3.02 | 4.74 | 3.35 | 3.55 | 4.20 | 3.33 | 3.72 | 3.63 | 3.44 |

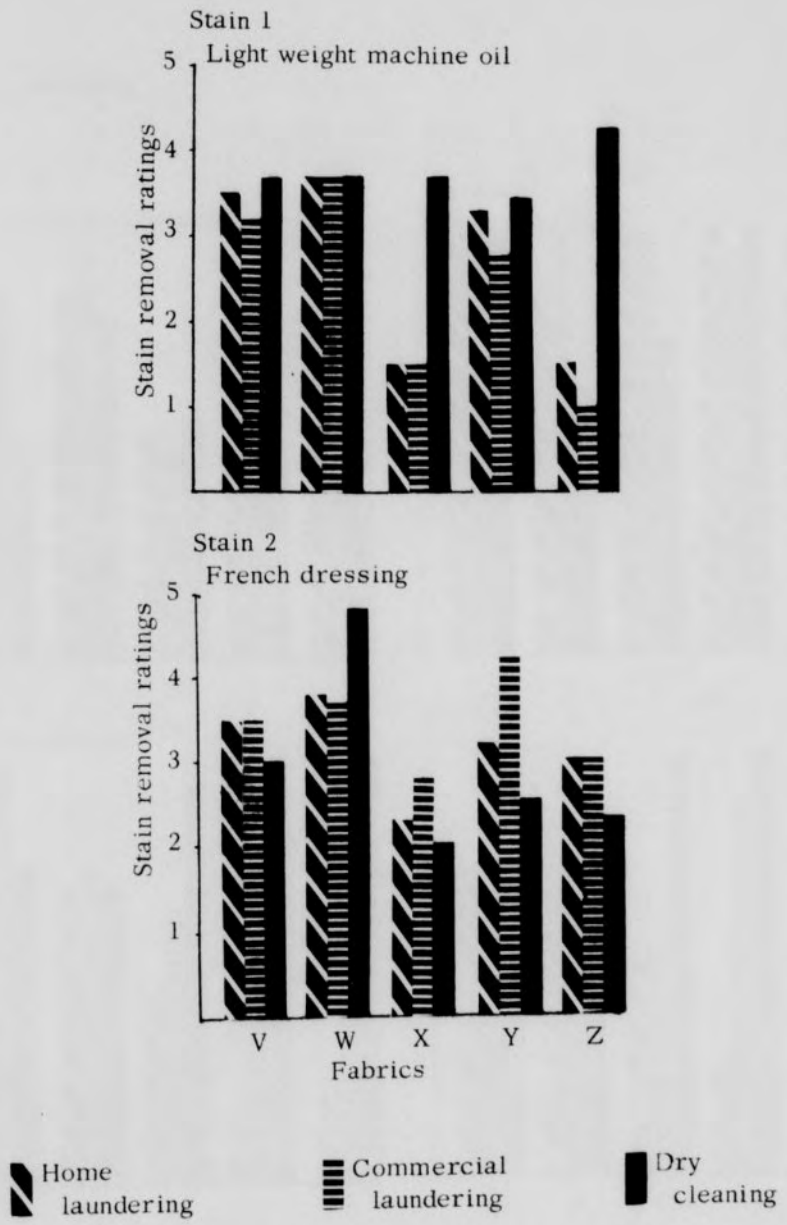



FIGURE 3

A COMPARISON OF THE EFFECTIVENESS OF STAIN REMOVAL FROM FIVE DURABLE PRESS TREATED FABRICS BY THREE CLEANING METHODS

FIGURE 3 (continued)

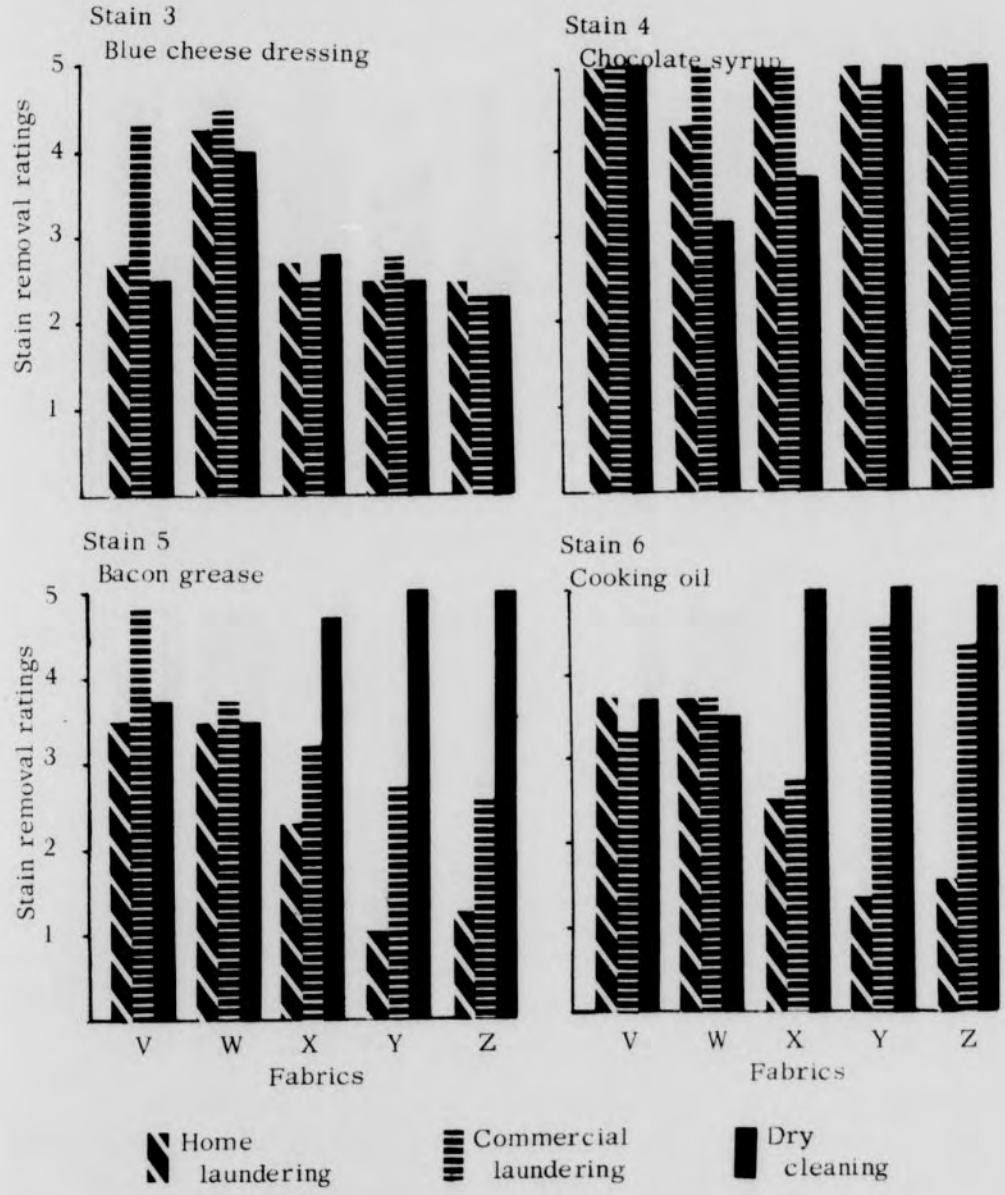
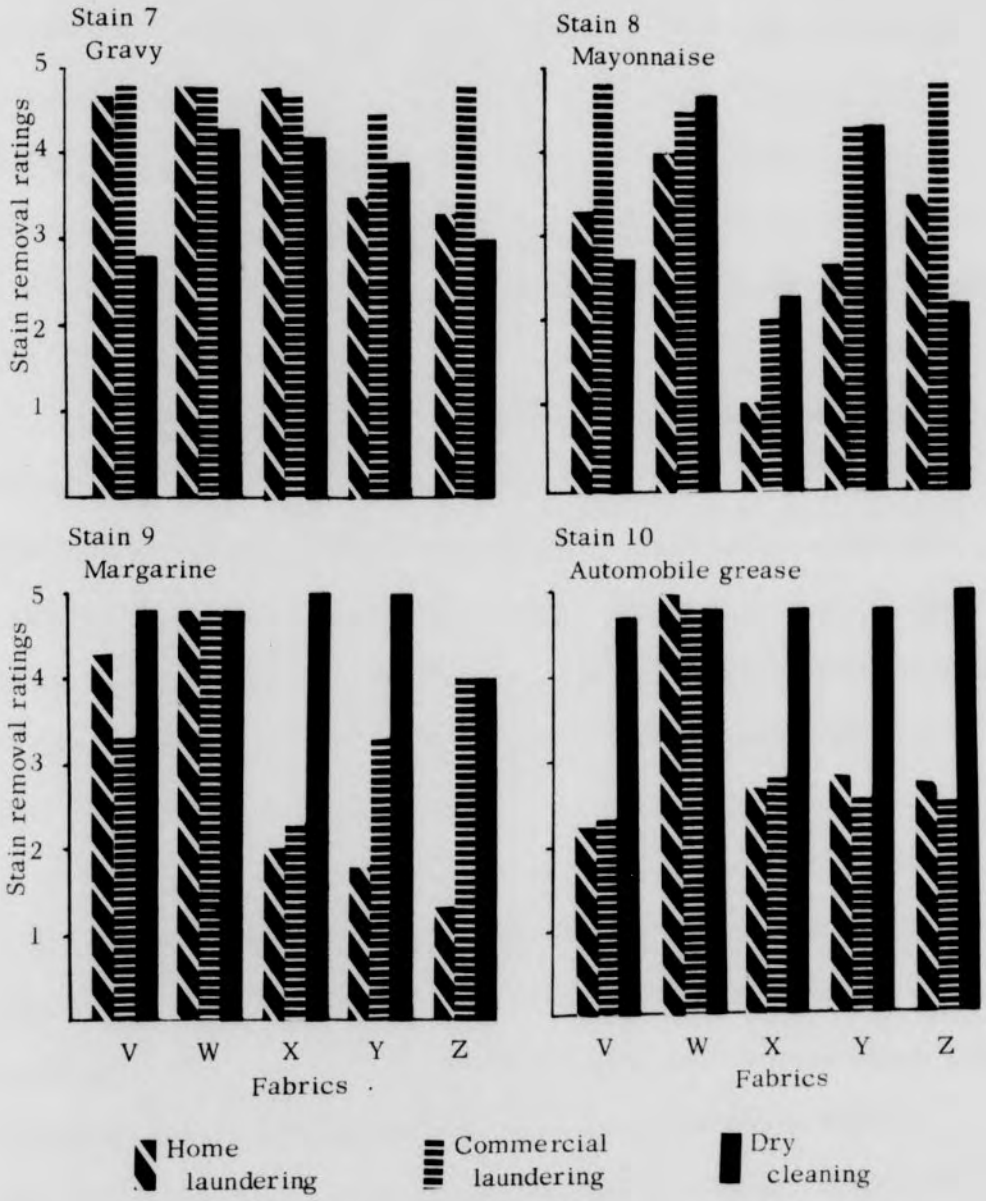


FIGURE 3 (continued)



carried to the nearest tenth.

Light weight machine oil. The three cleaning methods showed equal effectiveness in removing the machine oil from fabric W. The dry cleaning procedure was most effective on fabrics V, X, Y, and Z. However, only the rating for fabric Z exceeded 4, indicating some evidence of stain. Home laundering was least effective in removing the machine oil from fabrics V, Y, and Z. On fabric X the home laundering and commercial laundering procedures were equally effective.

French dressing. The commercial laundering procedure was most effective in removing the French dressing from fabrics X and Y; on fabrics V and Z it equalled home laundering. On fabric W, which was an acrylic and polyester blend, dry cleaning surpassed the laundering methods in the removal of this stain. Dry cleaning, which did not exceed a rating of 3 on fabrics V, X, Y, and Z, was least effective in removing the French dressing from these fabrics, all of which contained cotton.

Blue cheese dressing. Commercial laundering was rated as most effective in removing blue cheese dressing from fabrics V, W, and Y. Dry cleaning was most effective in fabric X; home laundering on fabric Z. The dry cleaning procedure was least effective in removing the stain from fabrics V and W. Home laundering and dry cleaning were equally effective on fabric Y, whereas commercial laundering and dry cleaning were equally effective on fabric Z.

Chocolate syrup. The chocolate syrup was completely removed from

fabrics V and Z by all of the cleaning methods. Commercial laundering excelled the other methods on fabric W, also receiving a rating of 5. Home laundering and commercial laundering left no evidence of stain on fabric X; home laundering produced the same results on fabric Y. Dry cleaning was noticeably less effective than the other two methods on fabrics W and X.

Bacon grease. Dry cleaning was rated as the most effective method in the removal of bacon grease from the deferred cured fabrics, X, Y, and Z; but the least effective on V and W. Both fabrics V and W were treated by the precure process. The home laundering procedure was least effective in removing the bacon grease from fabrics V, X, Y, and Z. The ratings for home laundering and dry cleaning were equal on fabric W.

Cooking oil. There was little variation between the ratings of the effectiveness of the three cleaning methods in removing cooking oil from fabrics V and W. The dry cleaning procedure completely removed the cooking oil from fabrics X, Y, and Z. Home laundering was considerably less effective on these three fabrics which were treated by the deferred cure process.

Gravy. Commercial laundering received ratings of 4.5 and above in the removal of gravy from all of the fabrics. The home laundering procedure received similar ratings on fabrics V, W, and X. In removing the stain from fabrics V, W, X, and Z, dry cleaning proved least effective.

Mayonnaise. Mayonnaise was most successfully removed from fabrics V and Z by commercial laundering. Dry cleaning was most effective in removing the stain from fabrics W and X. The ratings of commercial laundering and dry

cleaning were equal for fabric Y. Dry cleaning proved to be the least effective in removing the stain from fabrics V and Z, whereas home laundering was the least effective treatment used on fabrics X and W.

Margarine. The three cleaning methods were equally effective in removing margarine from fabric W. Commercial laundering and dry cleaning were equally effective on fabric Z. The dry cleaning procedure was noticeably the most effective in removing the stain from fabrics V, X, and Y. The stain showed most resistance to removal from fabrics X, Y, and Z by the home laundering procedure. Commercial laundering proved to be the least effective on fabric V.

Automobile grease. There was only a slight variation in the effectiveness of the three cleaning methods in removing automobile grease from fabric W. The dry cleaning procedure received mean ratings of 4.8 and above in the removal of the stain from all the fabrics. The ratings of home laundering and commercial laundering given to fabrics V, X, Y, and Z ranged from 2.8 to 2.2, showing relatively little effectiveness in the removal of this stain.

Stain removal from all fabrics. Figure 4 illustrates the variation in effectiveness of removal of each of the ten stains from all of the durable press fabrics using the three cleaning methods. The dry cleaning procedure was most effective in the removal of machine oil, bacon grease, cooking oil, margarine, and automobile grease from all the fabrics. This method was least effective on French dressing, blue cheese dressing, chocolate syrup, and gravy. This reaction could be credited to the presence of starches, sugars and

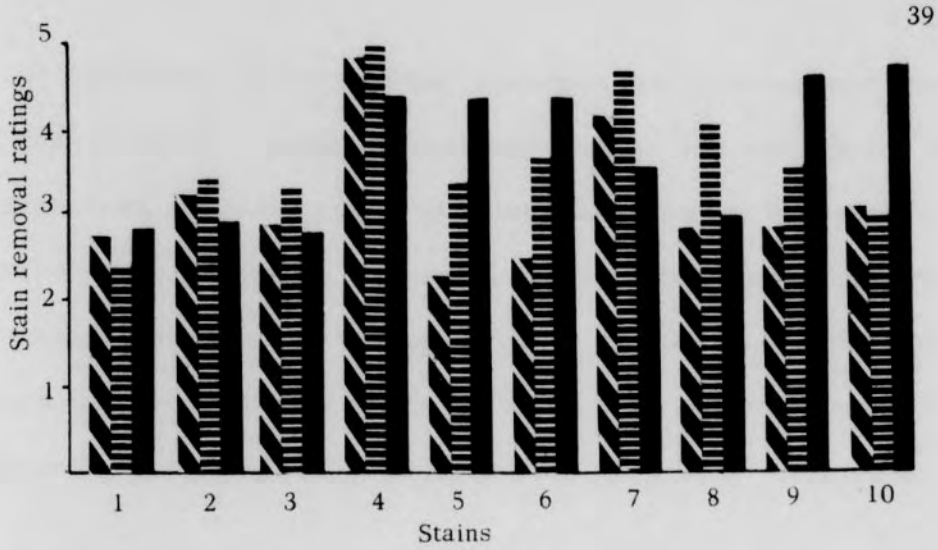



FIGURE 4

MEAN RATINGS OF STAIN REMOVAL FROM ALL THE DURABLE PRESS TREATED FABRICS BY THREE CLEANING METHODS

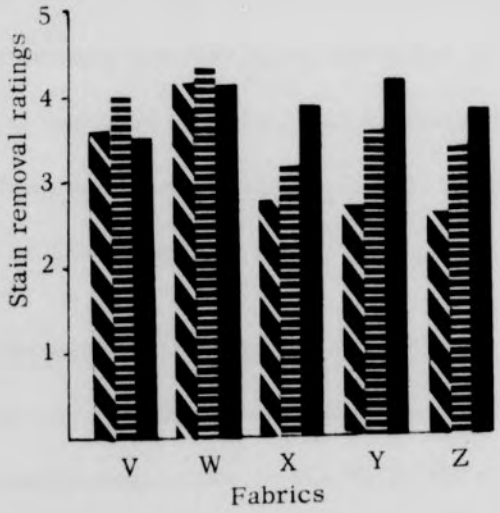
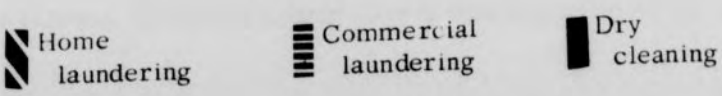



FIGURE 5

MEAN RATINGS OF REMOVAL OF ALL THE TEN STAINS FROM THE FIVE DURABLE PRESS TREATED FABRICS BY THREE CLEANING METHODS



milk in these stains. It was found that commercial laundering was most effective on these stains. Commercial laundering, however, was least effective on machine oil and automobile grease, while home laundering was least effective on bacon grease, cooking oil, mayonnaise, and margarine. Home laundering by the method used in this study was not superior in effectiveness of removing any of the stains. In the removal of six of the stains, home laundering was rated between the most and least effective methods.

Fabrics Evaluated on Stain Removal

The mean ratings of removal of all the stains from the five fabrics is shown in Figure 5. A definite difference in the effectiveness of the cleaning methods on the selected pre-cured and deferred cured fabrics was evidenced. Commercial laundering was superior on the pre-cured fabrics, V and W, whereas dry cleaning was least effective. Dry cleaning was superior in stain removal from the deferred cured fabrics, X, Y, and Z, while home laundering was least effective on this group.

Summary of Effectiveness of Stain Removal

Figure 6 summarizes the overall effectiveness of stain removal according to (1) the mean ratings of the ten stains, (2) the mean ratings of the five fabrics, and (3) the mean ratings of the three cleaning methods.

Only chocolate syrup and gravy received mean ratings of above 4.0, indicating that these stains were relatively successfully removed from the selected fabrics. It is interesting to note that these two stains penetrated only

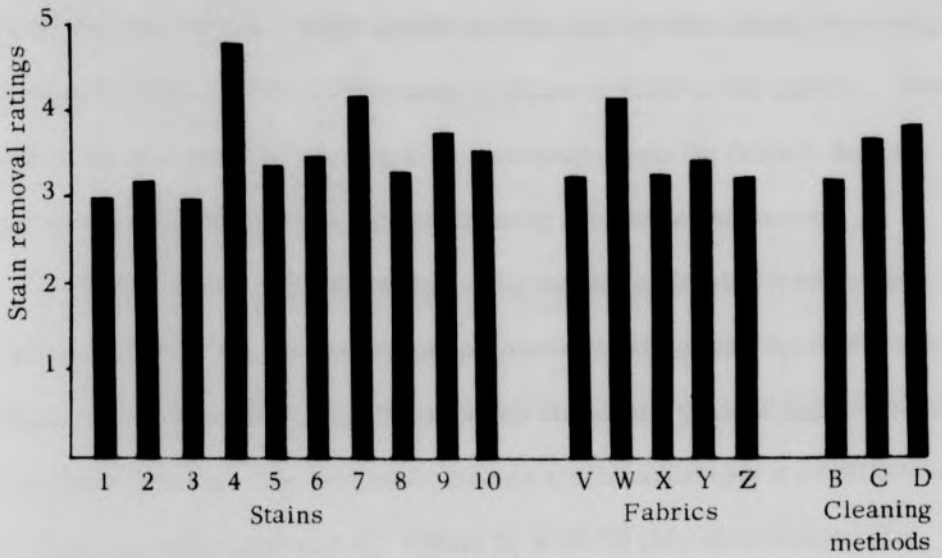



FIGURE 6

A SUMMARY OF THE EFFECTIVENESS OF STAIN REMOVAL ACCORDING TO THE RATINGS OF THE TEN STAINS, FIVE FABRICS, AND THREE CLEANING METHODS

Fabrics

| | |
|---|---|
| V | 65/35 polyester/cotton, plain weave, pre-cured |
| W | 50/50 acrylic/polyester, twill weave, pre-cured |
| X | 50/50 polyester/cotton, plain weave, deferred cured |
| Y | 85/15 cotton/nylon, twill weave, deferred cured |
| Z | 50/50 polyester/cotton, twill weave, deferred cured |

Stains

| | | | |
|---|---|---|---|
| 1 | Light weight machine oil | 6 | Cooking oil |
| 2 | French dressing | 7 | Gravy |
| 3 | Blue cheese dressing | 8 | Mayonnaise |
| 4 | Chocolate syrup | 9 | Margarine |
| 5 | Bacon grease | 10 | Automobile grease |

Cleaning methods

| | |
|---|---|
| B | Home laundering |
| C | Commercial laundering |
| D | Dry cleaning |

Stain removal rating scale

| | |
|---|---|
| 5 | No evidence of stain |
| 4 | Some evidence of stain |
| 3 | Moderate evidence of stain |
| 2 | Some evidence of removal |
| 1 | No evidence of removal |

slightly into the fabrics. Light weight machine oil and blue cheese dressing, with mean ratings of 3.0, left the most evidence of stain on the fabrics. The machine oil was rated as showing more penetration into the fabrics than any other stain, whereas the blue cheese dressing showed no penetration.

The removal of all the stains using the three cleaning methods was superior on fabric W, the acrylic and polyester blend, which received a mean rating of 4.2. This fabric also repelled the stains to a greater degree than any of the other fabrics. The four other fabrics which varied only a small amount were cumulatively rated at 3.4. Fabric Z, a 50/50 polyester/cotton blend, was given one of the lowest ratings of stain removal and showed the least repellancy to the stains.

The dry cleaning procedure used in this study was most effective in removing all the stains from the fabrics, receiving a rating of 3.9. The commercial laundering procedure was slightly less effective, and the home laundering procedure was least effective in removing the stains from the durable press treated fabrics.

# CHAPTER V

## SUMMARY AND CONCLUSIONS

### I. REVIEW OF THE STUDY

Durable press fabrics are the textile manufacturer's current answer to the consumer's demand for garments which retain their original appearance and require minimum care. Although wrinkle resistance and wrinkle recovery of durable press treated fabrics surpass fabrics treated by other methods, certain undesirable characteristics have appeared to result from the application of this finish. One such problem has been the removal of spots and stains from durable press fabrics.

The objectives of this study were (1) to evaluate the staining speed and penetration characteristics of ten selected oily and oil-borne stains applied to five durable press fabrics and (2) to determine the effectiveness of the removal of these stains by three cleaning methods or treatments. Answers to the following questions were sought in reference to the selected stains, fabrics, and cleaning methods.

1. Is there a difference in stain penetration among the ten stains and among the five fabrics?
2. Is there a difference between the ten stains in their removal from the five fabrics by home laundering, commercial laundering, and dry cleaning?

3. Is there a difference between the five fabrics in removal of the ten stains by home laundering, commercial laundering, and dry cleaning?

4. Is there a difference between the three cleaning methods in their effectiveness to remove the stains from the five fabrics?

5. Which stain, fabric, and cleaning method appear to contribute most to the successful removal of the stains?

6. Is there a positive relationship between the stain penetration and stain removal ratings for the fabrics and stains?

Five durable press finished garments were selected from those available in the Greensboro, North Carolina area. The fabrics from which these garments were made differed in fiber content, weave, and process used in applying the durable press treatment. Sections of each garment were marked into three inch squares for staining.

Ten oily and oil-borne stains were selected for their reputed difficulty of removal. The stains were: light weight machine oil, French dressing, blue cheese dressing, chocolate syrup, bacon grease, cooking oil, gravy, mayonnaise, margarine, and automobile grease.

One drop of stain was applied to each square of fabric. Five minutes following the application of the stain it was judged by the researcher to determine the penetration or repellancy characteristics. The stain penetration was rated on a five point scale. A rating of 5 denoted that the stain formed a ball on the fabric; a rating of 1 indicated that the stain was absorbed in a wide area. After the five minute period any excess stain remaining on the surface of the fabric was removed with a spatula.

The stains were then allowed to age on the fabrics two or more days

before any cleaning treatment was applied. Three methods of cleaning were used for removing the stains. These were selected procedures of home laundering, commercial laundering, and dry cleaning.

The effectiveness of stain removal was judged on a five point scale by three individuals who referred to a standard chart illustrating the extreme ratings. The following scale was used to rate the effectiveness of stain removal from the five fabrics.

| | |
|---|---|
| 5 | No evidence of stain |
| 4 | Some evidence of stain |
| 3 | Moderate evidence of stain |
| 2 | Some evidence of removal |
| 1 | No evidence of removal[1] |

Ratings of 5 were highly desirable; however, ratings of 4 and above were considered acceptable as showing only a small evidence of stain. Any rating below 4 was considered to indicate ineffective or undesirable stain removal characteristics.

Evaluation of Stain Penetration

Mean ratings of the variables, stain and fabric, indicated differences within these factors. French dressing, blue cheese dressing, chocolate syrup, gravy, margarine, and automobile grease showed very little absorption, while light weight machine oil, bacon grease, and cooking oil were readily absorbed. The mean ratings indicated only a small difference, from 4.08 to 3.31 between

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[1]Alice J. Willingham, "The Staining Characteristics of Cotton Wash-Wear Fabrics," (unpublished Grant-in-Aid, No. 91, The Research Council, The Woman's College of the University of North Carolina, Greensboro, 1961), p. 14.

the fabrics in stain repellancy. Fabric W repelled the stains more effectively than the other four fabrics. These four received approximately the same ratings.

Evaluation of Stain Removal

The mean ratings of stain removal indicated variances within the stains, the fabrics, and the cleaning methods.

The mean ratings of the removal of the ten stains ranged from 4.8 to 3.0, giving a grand mean of 3.6. This rating indicated that there was some evidence of stain remaining on the fabrics after the cleaning treatments. Chocolate syrup and gravy were most successfully removed from the five fabrics by the three cleaning methods. Light weight machine oil and blue cheese dressing were rated as the most difficult to remove.

There appeared to be a distinct difference between the pre-cured and deferred cured fabrics in the effectiveness of stain removal by the three methods. Commercial laundering slightly exceeded the other methods on the pre-cured fabrics, whereas dry cleaning was noticeably more effective on the deferred cured fabrics. The five durable press fabrics ranged from ratings of 4.2 to 3.3 in their ability to release the ten stains by the three cleaning methods. The grand mean rating of the five fabrics was 3.5, indicating that there still remained some to moderate evidence of stain on the fabrics.

Dry cleaning was found to be the most effective method of removing the selected stains from the fabrics used in this study. The home laundering procedure used proved to be the least effective. The mean ratings of stain removal

by the three methods ranged from 3.9 to 3.2 with a grand mean of 3.6, which denoted evidence of stain on the fabrics.

Neither the stains, the fabrics, nor the cleaning methods used in this study received grand mean ratings of stain removal above 3.6. This grand mean is below the rating of 4, which was arbitrarily established as the standard for effective stain removal.

Relationship of Stain Penetration and Stain Removal

Three of the ten stains appeared to have a positive relationship between stain penetration and stain removal. Chocolate syrup and gravy, which were repelled by the fabrics or showed only slight penetration, received stain removal ratings of above 4. Light weight machine oil, which showed the widest penetration into the fabrics, received the lowest stain removal rating.

Fabric W, the acrylic and polyester blend, was rated at 4 and above on both stain repellancy and stain removal, indicating that the fabric absorbed little stain and that the stain was satisfactorily removed. Fabric Z, a 50/50 polyester and cotton blend, received the lowest mean ratings of stain repellancy and stain removal.

## II. CONCLUSIONS

From the data obtained in this study of the removal of the selected stains from the five durable press fabrics by the three cleaning procedures, the following conclusions were drawn:

1. There was a noticeable difference in stain penetration related to the ten stains, whereas there was little difference between the fabrics in stain repellancy.

2. None of the ten stains was completely removed from all the fabrics using any one of the cleaning methods.

3. None of the five fabrics completely released all of the stains using any one of the cleaning methods.

4. None of the three cleaning methods completely removed all the stains from any one of the five fabrics.

5. A pattern was evidenced in the effectiveness of the cleaning methods among the pre-cured fabrics and among the deferred cured fabrics.

6. The dry cleaning procedure was most effective in removing the stains from the durable press fabrics; the home laundering procedure was the least effective.

7. There were positive relationships between certain stain penetration and stain removal ratings.

## III. RECOMMENDATIONS

Suggestions for further study are that additional experimentation be carried out on removing stains from durable press treated fabrics. Specific recommendations are:

1. A comparison of the effectiveness of stain removal from durable press fabrics on which the stains have aged before cleaning and from those which are cleaned immediately after the application of the stains.

2. The effectiveness of stain removal from durable press fabrics by spotting treatments.

3. A comparison of stain removal from 100 per cent cotton and all synthetic fabrics treated with a durable press finish.

4. A comparison of the effectiveness of stain removal from durable press fabrics which are treated with a soil-releasing component and from durable press fabrics without this treatment.

5. The development of non-subjective rating devices for evaluating stain penetration and stain removal.

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# APPENDIX

# APPENDIX A

RATING SHEET Judge Number____

Directions: Rate the fabrics mounted on the cards according to the following scale, using the chart on the viewing board as a reference. Place the code on the card in the left column, your rating in the right column below:

5 No evidence of stain
4 Some evidence of stain
3 Moderate evidence of stain
2 Some evidence of removal
1 No evidence of removal

| Code | Rating | Code | Rating | Code | Rating |
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